

Global impact of Biotech crops: economic & environmental effects in the first ten years of commercial use

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Coverage

- Presenting findings of full report available from ISAAA on www.isaaa.org & www.pgeconomics.co.uk
- Version in peer reviewed journal: AgbioForum (Jan 2007) www.agbioforum.org
- Cumulative impact: 1996-2005
- Farm income impact: focuses on farm income
- Environmental impact analysis covering pesticide spray changes & associated environmental impact
- Environmental impact analysis: greenhouse gas emissions

Methodology

- Literature review of economic impact in each country – collates & extrapolates existing work
- Uses current prices, exch rates and yields (for each year): gives dynamic element to analysis
- Review of pesticide usage (volumes used) or typical GM versus conventional treatments
- Use of Environmental Impact Quotient (EIQ) indicator
- Review of literature on carbon impacts – fuel changes and soil carbon

Methodology: EIQs

- From Kovach et al (1992)
- Integrates various env impacts of indiv pesticides into a single field value/ha – allows for comparisons between products
- Is consistent and fairly comprehensive
- Compares level of use on GM with conventional crop usage to deliver equal level of efficacy

Key Findings

Pesticide Reduction

224 million kg
reduction in pesticides &
15% cut in associated
env impact

Carbon Emissions

2005 = cut of 9
billion kg co2
release; equiv
to taking 4
million cars off
the road

Global Farm Income

\$27 billion
increase

After 10 years of commercialization, biotech crops have yielded a net increase in farm income while significantly reducing environmental impact.

Farm level economic impact

- 2005: farm income benefit \$5.6 billion
- 2005: equiv to adding value to global production of these crops of 3.6% to 4.0%
- 55% of farm income gain in 2005 to farmers in developing countries
- Since 1996, farm income gain = \$27 billion

Farm income effect: million \$

| Trait | Increase in farm income 2005 | Increase in farm income 1996-2005 | Farm income benefit in 2005 as % of total value of production of these crops in GM adopting countries | Farm income benefit in 2005 as % of total value of global production of these crops |
|----------------|------------------------------|-----------------------------------|---|---|
| GM HT soybeans | 2,281 (2,842) | 11,686 (14,417) | 5.72 (7.1) | 4.86 (7.1) |
| GM HT maize | 212 | 795 | 0.82 | 0.39 |
| GM HT cotton | 168 | 927 | 1.16 | 0.64 |
| GM HT canola | 195 | 893 | 9.45 | 1.86 |
| GM IR maize | 416 | 2,367 | 1.57 | 0.77 |
| GM IR cotton | 1,732 | 7,510 | 12.1 | 6.68 |
| Others | 25 | 66 | N/a | N/a |
| Totals | 5,027 (5,588) | 24,244 (26,975) | 6.0 (6.7) | 3.6 (4.0) |

Notes: Bracketed figures include second crop benefits in Argentina

Farm income gains: by country: 1996-2005 million \$



Since 1996, biotech crops have increased farm income \$27 billion.

Other farm level benefits

| GM HT crops | GM IR crops |
|---|--|
| Increased management flexibility/convenience | Production risk management tool |
| Facilitation of no till practices | Energy cost savings |
| Cleaner crops = lower harvest cost & quality premia | Machinery use savings |
| Less damage in follow on crops | Convenience benefit |
| | Improved crop quality |
| | Improved health & safety for farmers/workers |

Impact on pesticide use

- Significant reduction in global environmental impact of production agriculture
- Since 1996 use of pesticides down by 224 m kg (-6.9%) & associated environmental impact - 15.3%
- In 2005, reduction in volume of use is equivalent to 40% of total ai use in EU arable crop production

Impact on pesticide use

- Largest gains in soy sector: -51m kg (-4.1%) since 1996 & 20% decrease in environmental impact
- Major gains with GM IR cotton: - 94 m kg insecticide (-19%) & 24% reduction in env impact
- Important gains in corn sector: 4% & 4.6% respective reduction in env impact for HT & IR traits
- Greatest gains in US, Canada, Argentina & China

Changes in the use of herbicides & insecticides from growing GM crops globally 1996-2005

| Trait | Change in volume of active ingredient used (million kg) | Change in field EIQ 'foot print' (in terms of million field EIQ/ha units) | % change in ai use in GM growing countries | % change in environmental 'foot print' in GM growing countries |
|----------------|---|---|--|--|
| GM HT soybeans | -51.4 | -4,865 | -4.1 | -20.0 |
| GM HT maize | -36.5 | -845 | -3.4 | -4.0 |
| GM HT cotton | -28.6 | -1,166 | -15.1 | -22.7 |
| GM HT canola | -6.3 | -310 | -11.1 | -22.6 |
| GM IR maize | -7.0 | -403 | -4.1 | -4.6 |
| GM IR cotton | -94.5 | -4,670 | -19.4 | -24.3 |
| Totals | -224.3 | -12,259 | -6.9 | -15.3 |

Impact on greenhouse gas emissions

Lower GHG emissions: 2 main sources:

- Reduced fuel use (less spraying & soil cultivation)
- GM HT crops facilitate no till systems = less soil preparation = additional soil carbon sequestration

Reduced GHG emissions: 2005

- Reduced fuel use (less spraying & tillage) = 962 million kg less carbon dioxide
- Facilitation of no/low till systems = 8,053 m tonnes of carbon dioxide not released into atmosphere

=



Equivalent to removing 4 million cars — 17% of cars registered in the United Kingdom — from the road for one year

Reduced GHG emissions: 1996-2005

- less fuel use = 2 m cars off the road (9% UK cars)
- additional soil carbon sequestration – not possible to estimate (depends on % of crops kept in continuous no till)

The future

- Possibly 200 m ha of biotech crops grown by 20 m farmers by 2015 (ISAAA forecast)
- Application of existing traits to wider range of crops
- New traits like drought tolerance
- New quality traits like high omega-3 oil content crops

Concluding comments

- Technology used by 8.5 m farmers on 87 m ha (2005)
- Delivered important economic & environmental benefits
- + \$27 billion to farm income since 1996
- -224 m kg pesticides & 15% reduction in env impact associated with pesticide use since 1996
- Carbon dioxide emissions down by 9 billion kg in 2005: equal to 4 m cars off the road for a year

Concluding comments

- GM IR technology: improved profits & env gains from less insecticide use
- GM HT technology: combination of direct benefits (mostly cost reductions) & facilitation of changes in farming systems (no till & use of broad spectrum products) plus major GHG emission gains
- Expect continued wider adoption of technology = improved profitability, improved environment